

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	: Colbert, et al.	Art Unit	: 1754
Serial No.	: 10/670,955	Examiner	: James Fiorito
Filed	: September 25, 2003	Conf. No.	: 7093
Title	: METHOD FOR END-DERIVATIZING SINGLE-WALL CARBON NANOTUBES		

**Mail Stop Appeal Brief - Patents**

Commissioner for Patents

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**REPLY BRIEF**

Pursuant to 37 C.F.R. § 41.41, Applicant responds to the Examiner's Answer, mailed September 6, 2007 ("Examiner's Answer") in response to the Appeal Brief filed May 9, 2007 (the "Appeal Brief"), and the Amended Appeal Brief filed July 5, 2007 (the "Amended Appeal Brief"), as follows.

**I. STATUS OF CLAIMS**

Claims 84-85, 91-92, and 94-95 are pending in the Application.

Claims 84-85, 91-92, and 94-95 stand rejected.

Claims 84-85, 91-92, and 94-95 are being appealed.

**II. GROUND OF REJECTION TO BE REVIEWED ON APPEAL**

A. Withdrawn by Examiner.

B. Claims 84-85, 91-92, and 94-95 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,698,175 to Hiura ("*Hiura*") in view of "Single-shell carbon nanotubes of 1-nm diameter," Iijima *et al.*, *Nature*, Vol. 363, pp.603-605 (June 1993) ("*Iijima*").

### III. ARGUMENTS

#### A. Claims 94 and 95 Comply With 35 U.S.C. § 112, ¶ 1

In Examiner's Answer, Examiner has withdrawn the rejection of Claim 94 and 95 under 35 U.S.C. § 112, ¶ 1, as failing to comply with the written description requirement. Answer, at 2.

#### B. 35 U.S.C. § 103(a) Rejection of Claims 84-85, 91-92, and 94-95 over *Hiura* in view of *Iijima*

In its Amended Appeal Brief, Applicant showed the Examiner failed to establish a *prima facie* case of obviousness by (1) failing to identify and acknowledge crucial differences between *Hiura* and *Iijima* and the claims at issue, (2) failing to show a reasonable expectation of success, (3) failing to properly resolve the level of ordinary skill in the art, (4) failing to properly consider the evidence of secondary considerations, and (5) using impermissible hindsight reasoning. Amended Appeal Brief, at 5-12. As discussed below, Examiner's Answer reflects each of these deficiencies exist and remain. Thus, the claims of the present Application are not obvious.

##### 1. Examiner Failed to Identify and Acknowledge Crucial Differences Between *Hiura* And *Iijima* And The Claims At Issue

In its Amended Appeal Brief, Applicant discussed in detail critical differences between the prior art and the claims-in-issue, including the fact that *Hiura* relates to *multi-wall* carbon nanotubes, not single-wall carbon nanotubes, and that there are significant differences in terms of structure, properties, and chemical reactivity between multi-wall and single-wall carbon nanotubes. See Amended Appeal Brief, at 6-8. While Examiner acknowledged that, "*Hiura* does not expressly state that the carbon nanotubes are single-wall carbon nanotubes," (Examiner's Answer, at 3), and Examiner does not disagree that *Hiura* disclosed only multi-wall carbon nanotubes (while *Iijima* discloses single-wall carbon nanotubes), the Examiner failed to acknowledge (and essentially ignores) the crucial differences between multi-wall carbon nanotubes and single-wall carbon nanotubes (including differences with respect to their structure, properties, and chemical reactivity).

Rather, in Examiner's Answer, Examiner avoids addressing these differences by stating "*Hiura* and *Iijima* are analogous art because they are from the same field of endeavor, namely processes involving carbon nanotubes." Examiner's Answer, at 4. And by overlooking these

differences, the Examiner is then able to contend that "[a]t the time of invention, it would have been obvious to a person of ordinary skill in the art to form the process of *Hiura* to include the use of single walled carbon nanotubes in view of the teaching of *Iijima*. The suggestion or motivation of doing so would have been to derivatize single-walled carbon nanotubes." Examiner's Answer, at 4.

By doing so, Examiner completely discounts the significant physical differences between multi-wall and single-wall carbon nanotubes that results in the chemistry that can be done with each species to be both quite different as well as unpredictable.

This is wrong, and the significant physical differences between multi-wall and single-wall carbon nanotubes are crucial differences that must be addressed during the obviousness analysis. For instance, in its Amended Appeal Brief, Applicant showed *Hiura* primarily taught the purification of multi-wall carbon nanotubes, and such purification of *Hiura* was carried out by reacting such multi-wall carbon nanotubes with highly oxidative acids and/or oxidation agents under reflux and/or ultrasonic conditions. Appeal Brief, at 8. As shown graphically in Fig. 3 of *Hiura*, this purification damaged the multi-wall structures. *Id.* This was because application of the teachings of *Hiura* to multi-wall carbon nanotubes, typically riddled with defects, resulted in the breaking of carbon-carbon bonds generally at regions of defects on the walls as well as the ends. *Id.* Because of their multi-wall structure, the multi-wall nanotubes can withstand attack to their wall layers and still remain intact; however, as would be appreciated by one of skill in the art at the time of the present invention, such bond splitting with single-wall carbon nanotubes would be expected to result in destruction of the single-wall nanotubes. *Id.*

Examiner does not respond to this showing by Applicant at all in Examiner's Answer, presumably because Applicant's showing is correct and indisputable.

In addition, the impact and effect of Examiner's failure to recognize and acknowledge these crucial differences permeates throughout Examiner's analysis, including as discussed below.

## **2. Examiner Failed to Show There Was A Reasonable Expectation of Success**

In its Amended Appeal Brief, Applicant established that a person of ordinary skill in the art of the Application at the time of the invention *would not* have reasonably expected the

process of *Hiura* would succeed for single-wall carbon nanotubes. Rather, a person of ordinary skill in the art would have reasonably believed the processes taught and disclosed in *Hiura* would destroy single-wall carbon nanotubes, which, in fact, was a view that was widely held by those skilled in the art at the time of the present invention (and well after the publication dates of *Hiura* and *Iijima*). Amended Appeal Brief, at 8.

In response, Examiner takes the position that Applicant's argument is not persuasive, and relies upon Applicant's own Application as evidence to assert that "it appears that the process of *Hiura* in view of *Iijima* and the instant claimed process produce similar results." Examiner's Answer, at 5.

Examiner's position is incorrect.

Applicant's own Application is not (and cannot be) evidence that Examiner can utilize to assert there was a reasonable expectation of success, and it is improper to use Applicant's own Application for such purpose. Amended Appeal Brief, at 10. Thus, Examiner has presented no basis whatsoever to support Examiner's position that there was any reasonable expectation of success.

On the other hand, Applicant firmly established why one of ordinary skill in the art would not have been motivated to modify the teachings of *Hiura* with those of *Iijima* to arrive at the elements of the claimed invention (including for the reasons discussed in Applicant's Amended Appeal Brief and noted above in Section B.1., to which the Examiner has apparently conceded by failing to respond to such reasons in Examiner's Answer).

Furthermore, Applicant has presented strong (and un-refuted) objective evidence of nonobviousness also establishing that there was no reasonable expectation of success, which objective evidence included *Dujardin* (attached to Amended Appeal Brief, at Exhibit A). Amended Appeal Brief, at 8-9 & Exhibit A. In its Amended Appeal Brief, Applicant specifically pointed out the text in *Dujardin* in which the authors of *Dujardin* expressly stated that oxidation processes (like those disclosed in *Hiura*) would work on multi-wall carbon nanotubes, but would destroy single-wall carbon nanotubes before anything else. Amended Appeal Brief, at 8-9. These statements in *Dujardin* were made a couple years *after* Applicant filed its initial application for the present invention; hence, this is very strong and direct evidence that there was no reasonable expectation of success at the time of the present invention.

As noted by Applicant in its Amended Appeal Brief, the import of this objective evidence is particular weighty in that *Dujardin* was co-authored by Dr. T.W. Ebbesen, a co-inventor of *Hiura* (the primary reference in the present § 103 rejection). Amended Appeal Brief, at 9-10. Hence, when the co-inventor of *Hiura* (perforce a person of *extraordinary* skill in the art) stated that oxidation processes, such as those disclosed in *Hiura*, would destroy single-wall carbon nanotubes, it strains credibility to contend that a person of ordinary skill in the art would years earlier have a reasonable expectation of success that the oxidation process of *Hiura* could be successfully utilized on single-wall carbon nanotubes.

Therefore, *Dujardin*, as objective evidence of nonobviousness, directly shows that a person of ordinary skill in the art *would not* have expected success, at the time of the invention, in achieving the results shown in the present Application. For that matter, this evidence clearly shows that even the inventors of *Hiura*, *who are of extraordinary skill in the art*, rather would not have expected this result. One of the indicia of nonobviousness is the determination that an invention would have been *nonobvious* to those of *extraordinary* skill, *i.e.*, other inventors in the art. *See Standard Oil Co. v. American Cyanamid Co.*, 774 F.2d 448, 454, 227 U.S.P.Q. 293, 297-98 (Fed. Cir. 1985); *Kimberly-Clark Corp. v. Johnson & Johnson*, 745 F.2d 1437, 1454, 223 U.S.P.Q. 603, 614 (Fed. Cir. 1984). Furthermore, "proceeding contrary to the accepted wisdom . . . is 'strong evidence of unobviousness.'" *In re Hedges*, 783 F.2d 1038, 1041, 228 U.S.P.Q. 685, 687 (Fed. Cir. 1986) (citing *W.L. Gore & Assoc., Inc. v. Garlock, Inc.*, 721 F.2d 1540, 1552, 220 U.S.P.Q. 303, 312 (Fed. Cir. 1983)).

And, as Examiner has failed to present any evidence reflecting a reasonable expectation of success (and likewise failed to refute any of the evidence Applicant has offered to show there was no reasonable expectation of success at the time of the present invention), a *prima facie* case of obviousness has not been established. M.P.E.P. § 2143.02.

### **3. Examiner Failed to Resolve The Level Of Ordinary Skill In The Pertinent Art**

As noted above, Applicant established in its Amended Appeal Brief that a person of ordinary skill in the art of the Application at the time of the invention would not reasonably have expected the process of *Hiura* would succeed for single-wall carbon nanotubes, but, rather, a

person of ordinary skill in the art would have reasonably believed the *Hiura* process would destroy the single-wall carbon nanotubes. Amended Appeal Brief, at 8-9.

To support that this was the level of ordinary skill in the art, Applicant presented *Dujardin*, which shows that persons of *extraordinary* skill in the art would have had no reasonable expectation of success at the time of the present invention, and, as such, a person of *ordinary* skill in the art would certainly not have expected success at that time. Amended Appeal Brief, at 8-9.

In Examiner's Answer, Examiner states that "[a]ny argument that one of ordinary skill in the art at the time of invention (e.g. "Hidefumi Hiura") would not be cognizant of single-walled carbon nanotubes and the design incentives present to derivatize them is greatly diminished with the facts of record. The fact that Hiura discloses the broader 'genus' of 'nanotubes' (i.e. by not differentiating between single-walled and multi-walled nanotubes) should not lead the Board to a conclusion that one of ordinary skill in the art was not aware of single-walled nanotubes, or that derivativizing a single-walled carbon nanotube was non-obvious." Examiner's Answer, at 6.

Examiner's argument is misplaced.

Applicant has not taken the position nor presented arguments that Drs. Hiura and Ebbesen (the co-inventors of *Hiura*) or that persons of ordinary skill in the art were not aware of single-wall carbon nanotubes. In fact, that Drs. Hiura and Ebbesen were aware of single-wall carbon nanotubes supports and provides credence to the nonobviousness of the present invention.<sup>1</sup> As noted above, Dr. Ebbesen is on record as stating that oxidation processes, such as disclosed in *Hiura*, would not be successful with the single-wall carbon nanotubes, and Dr. Ebbesen made such statements in *Dujardin* well after the publication dates of *Hiura* and *Iijima* (and *after* the present invention).

Thus, there can be no dispute as to the level of a person of ordinary skill in the art at the time of present invention would have believed the oxidation processes of *Hiura* should not be

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<sup>1</sup> Examiner devotes nearly a page of Examiner's Answer arguing that Drs. Hiura and Ebbesen (the co-inventors of *Hiura*) knew about single-wall carbon nanotubes at the time of filing of *Hiura*. Examiner's Answer, at 6-7. Nonetheless and despite this knowledge, as noted above, Drs. Hiura and Ebbesen were completely silent concerning single-wall carbon nanotubes in *Hiura*, which thus serves to make Applicant's point.

utilized on single-wall carbon nanotubes, as it was believed that such processes would destroy such single-wall carbon nanotubes.

**4. Examiner Failed to Properly Consider The Evidence Of Secondary Considerations**

As noted above, Appellant presented in its Amended Appeal Brief objective evidence of nonobviousness, including *Dujardin*. See, e.g., Amended Appeal Brief, at 9-12. Examiner has presented a myriad of reasons why the Board should simply ignore this evidence when analyzing the present obviousness rejections. Examiner's Answer, at 5-6.

Each of these reasons presented by Examiner is incorrect. Rather, objective evidence of non-obvious must be considered during a non-obviousness analysis. *KSR Int'l Co. v. Teleflex, Inc.*, 127 S. Ct. 1727, 1734, 82 U.S.P.Q.2d 1385 (2007); see also M.P.E.P. § 2141.

**a. *Dujardin* Is Objective Evidence of Nonobviousness That Can and Must Be Considered**

In its Examiner's Answer, the Examiner stated as follows:

Appellants' reliance on *Dujardin* is inapposite. Post-filing date references have no legal relevance to the novelty or obviousness analysis. See 35 U.S.C. §§ 102-103. The fact that *Dujardin* and coworkers – with the benefit of approximately three years of further study, reflection and hindsight from the work disclosed in US 5,698,175 to Hiura – et al. made some statement in an article published two years after the priority date of the instant application should not influence the Board. The Board should concern itself with the art of record that qualifies under 35 U.S. C. § 102 *only*.

Examiner's Answer at 5-6 (emphasis in the original).

Applicant notes Examiner has presented no legal basis for Examiner's position that post-filing date references have no legal relevance to the obviousness analysis. Nor could Examiner, as this is a complete mischaracterization of the law. Objective evidence of non-obviousness can and does include evidence that post-dates the effective filing date of the pertinent patent application. For instance, objective evidence of nonobviousness can include, among other things, evidence of commercial success, copying by others, tribute by others, and initial skepticism of the invention, *Electro Medical Systems, S.A. v. Cooper Life Sciences, Inc.*, 34 F.3d 1048, 1052-53, 32 U.S.P.Q.2d 1017 (Fed. Cir. 1994); *Hughes Tool Co. v. Dresser Industries, Inc.*, 816 F.2d 1549, 1556, 2 U.S.P.Q.2d 1396 (Fed. Cir. 1987). By and large, such evidence primarily (and, typically, exclusively) relates to circumstances that occur after the effective filing

date of the patent application. This is because a patentee generally does not commercialize or publicize its invention until after the effective filing date (and certainly does not do so more than a year before the effective filing date). As such, the commercial success, copying, tribute, and initial skepticism of the invention would then primarily (and, typically, exclusively) occur after the effective filing date (*i.e.*, post-filing). Also, for example, in *United States v. Adams*, 383 U.S. 39, 52, 148 U.S.P.Q. 479, 484 (1966), when holding the relevant invention nonobvious, the Supreme Court expressly relied upon patents that issued from applications filed after the patent-in-suit as objective evidence of nonobviousness. As such, Examiner's contention that references, such as *Dujardin*, that are dated after the effective filing date of the present invention have no relevance during an obviousness analysis is legally wrong.

Furthermore, it is specious that statements made by an inventor of the prior art patent (here Dr. Ebbesen of *Hiura*) are irrelevant to the obviousness of utilizing processes taught and disclosed in *Hiura* simply because Dr. Ebbesen made such statements after (rather than before) the effective filing date of the present application. In fact, under the circumstances, the evidence is more relevant because these statements were made after the effective filing date of the present application. Certainly, evidence that reflects a person of ordinary skill (and in this case extraordinary skill) in the art would not have a reasonable expectation of success two years after the present invention is highly indicative of the fact that a person of ordinary skill (and in this case extraordinary skill) in the art would have believed the same two years earlier (*i.e.* at the time of the invention). Thus, there can be no dispute that *Dujardin* is relevant to the obviousness analysis. See Fed. R. Evid. 401.<sup>2</sup>

As such, and contrary to the Examiner's statement, *Dujardin* is relevant objective evidence of nonobviousness.

Hence, it would be legal error and in complete contradiction to the long standing practice of the Supreme Court, the Federal Circuit (and its predecessor Court), and the USPTO, for the Board to accept Examiner's suggestion to concern itself with the art of record that qualifies

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<sup>2</sup> Fed. R. Evid. 401 defines "Relevant evidence" to mean "evidence having any tendency to make the existence of a fact that is of consequence to the determination of the action more probable or less probable than it would be without the evidence."



under 35 U.S. C. § 102 only. Thus, *Dujardin* can and must be considered by the Board during its analysis.

**b. *Dujardin* is directed to oxidation processes such as taught in *Hiura***

In Examiner's Answer, the Examiner further stated as follows:

Appellants argue that it would have been obvious to a person of ordinary skill in the art to combine *Hiura* and *Iijima* to successfully obtain the claimed invention. The appellants cite "gas-phase oxidation, which yields purified multishell nanotubes, destroys the single-shell nanotubes before anything else in the sample" found in [*Dujardin*] in support of this argument. However, gas-phase oxidation is not taught by the process of *Hiura*, and therefore the teaching of *Dujardin* does not sufficiently render the combination of *Hiura* and *Iijima* nonobvious.

Examiner's Answer at 5.

However, in view of these statements, the Examiner has apparently missed the crux of Applicant's arguments. Applicant agrees that *Hiura* teaches liquid-phase oxidation, however, the Examiner has no basis for dismissing the teachings of *Dujardin*, which refers to both liquid-phase and gas-phase oxidation, in evaluating the evidence of secondary consideration. Nonetheless, Examiner tries to dismiss *Dujardin* based upon the Examiner's contention that the "teachings of *Dujardin* only apply to only gas-phase oxidation of multi-shell nanotubes." Final Office Action, at 5. This contention is absolutely not true.

As Examiner expressed this contention during prosecution, Applicant addressed this contention in its Amended Appeal Brief (as Applicant had done in its responses during prosecution). See Amended Appeal Brief, at 9-10. To summarize again, *Dujardin* stated "It was believed that purification of single-shell nanotubes based on preferential oxidation and/or separation using surfactants was much more difficult than that of [multi-shell] nanotubes." *Dujardin*, at 611. This statement is footnoted by 4 papers, including end note [6], which is H. Hiura, T.W. Ebbesen, K. Tanigaki, *Adv. Mater.*, **1995**, *7*, 275 ("1995 *Hiura*"). See *Dujardin*, at 611 & 613. 1995 *Hiura* is entitled, "Opening and Purification of Carbon Nanotubes in High Yields," and was attached at Exhibit B in the Amended Appeal Brief.

1995 *Hiura* made clear that the authors (which included both Drs. Hiura and Ebbesen, the named inventors of *Hiura*), were trying "well-known oxidants, such as nitric acid, sulfuric acid,

the mixture of both and potassium permanganate" for opening and purifying multi-shelled carbon nanotubes. 1995 *Hiura*, at 275. Thus, this above-quoted statement in *Dujardin* clearly related to liquid-phase oxidation of single-shell and multi-shell nanotubes. Moreover, as noted above, one of the co-authors of *Dujardin*, Dr. Ebbesen was a named co-inventor of *Hiura*. See *Dujardin*, at 611 and *Hiura*, at cover page. Therefore, there can be no dispute that the authors of *Dujardin* were fully aware of the liquid-phase processes disclosed in *Hiura*, when providing this statement.

After this statement, *Dujardin* then stated another, specific example to further emphasize and embellish on the point of the difficulty of the "purification of single-shell nanotubes based on preferential oxidation," by following with the statement "For instance, gas-phase oxidation, which yields purified multishell nanotubes, destroys the single shell nanotubes before anything else in the sample." *Dujardin* at 611.

Thus, these statements in *Dujardin* clearly indicated that *Dujardin* was not just describing gas-phase processes when discussing the difficulty in purifying single-wall carbon nanotubes. And, thus, *Dujardin* cannot be disregarded as the Examiner suggests.

Applicant also notes that despite having provided Examiner the opportunity to address the above argument (by Applicant's presenting it in its Amended Appeal Brief), once again, Examiner has failed to respond or address this in Examiner's Answer. Again, this is presumably because Applicant's showing is correct and indisputable.

##### **5. Hindsight Reasoning Has Used Impermissibly Been Used in the Obvious Analysis**

As noted above, the Examiner has apparently and mistakenly relied on Applicant's own disclosure to argue that the unexpected result was expected. See Examiner's Answer, at 5. It is clearly impermissible, and in error to rely on Applicant's own disclosure in this manner, because, if this were allowed then there would never be "unexpected results" when the results of the applied for invention could be used to determine what a person of ordinary skill would have expected. In short, to protect against a hindsight analysis, the Applicant's own disclosure cannot be utilized in this manner.

This is a further reason why the objective evidence of nonobviousness cannot be ignored as Examiner suggests. Such objective evidence of nonobviousness "serve[s] as insurance against

the insidious attraction of the siren hindsight" when evaluating the prior art. *W.L. Gore*, 721 F.2d at 1553, 200 U.S.P.Q. at 313.

Accordingly, Examiner impermissibly relied on the Applicant's disclosure to show the invention was expected and, further, the Examiner ignored the teachings of *Hiura* and the statements made in the art (including in *Dujardin*) that show that a person of ordinary skill in the art would reasonably have been believed that the *Hiura* process would destroy single-wall carbon nanotubes.

For at least each of the reasons listed above, Examiner has again not established a *prima facie* case of obviousness.

For these reasons, and the reasons stated in the Amended Appeal Brief, Applicants submit that the final rejection should be reversed.

We believe that there are no fees due at this time; however, if we have calculated incorrectly, authorization is hereby given via the Electronic Filing System (EFS) by way of Deposit Account authorization. Please apply all charges or credits to Deposit Account No. 06-1050, referencing Attorney Docket No. 21753-011014.

Respectfully submitted,



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